Role of Deformation Twinning in Strain Hardening and Texture Evolution: Experiment and Numerical Simulation

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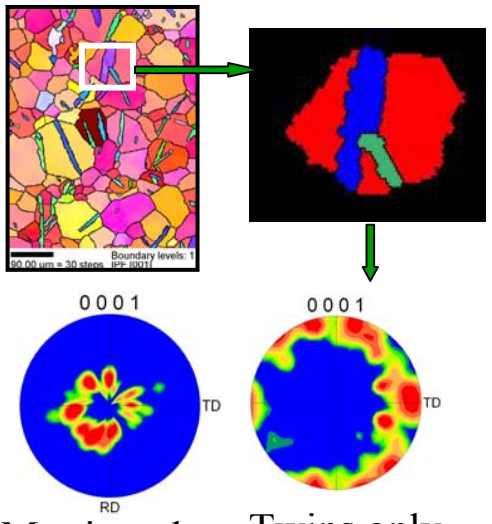
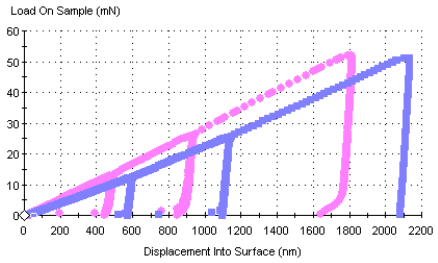
Deformation twinning is the second most prevalent mode of plastic deformation in metals. It was established that deformation twinning causes: (i) strain hardening of the material due to a reduction of the effective slip length, (ii) strain hardening due to increase in hardness of the twinned regions, and (iii) textural softening due to lattice reorientation of the twinned regions. These relationships were quantified and are being incorporated into a new crystal plasticity model that takes into account slip, twinning, and slip inside twins as possible modes of plastic strain (*Acta Materialia*, **51**, 4225, 2003).



Matrix only Twins only



We have also developed a new approach for extracting fundamental crystal level elastic parameters from the raw data obtained from nano-indentations at different locations in a polycrystalline sample. This is accomplished by concomitant measurement of crystal orientations around the indentations using orientation imaging microscopy (OIM). The validity of this new approach has been demonstrated by direct comparison of extracted elastic parameters against known values reported in handbooks for two polycrystalline materials – aluminum and titanium (submitted to *Advanced Materials*, 2004).

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Broad Impact:

- A strong collaboration was established with Dr. Lee Semiatin's research group at Air Force Research Lab, Dayton, OH. Three papers will be published shortly with co-authors from AFRL and our research group.
- Gwénaëlle Proust won the 3rd prize in the student paper competition at the 40th Annual Technical Meeting of SES Conference in Ann Arbor, MI in October 2003 for a presentation on the nanoindentation work.

Education:

- Gwénaëlle Proust and Xianping Wu and are currently pursuing their PhDs on this project.
- A high school student, Ivan Orlovski, worked with us part-time during 2003-2004. He is now enrolled as a freshman in computer science at Drexel University.
- Dan Satko, a freshman at Drexel University worked with our research group this summer for 10 weeks.
- Melanie Patel, an undergraduate student, has been working with our research group for more than an year. Because of early exposure to research, she is now motivated to pursue a BS/MS degree at Drexel University, while working on this project and expanding into novel material systems, including certain biological materials.